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(54) CONTINUOUS EXTRUSION OF ENDLESS SECTIONS

(71) We, FARBENFABRIKEN BAYER AKTIENGESELLSCHAFT, a body corporate organised under the laws of Germany, of 509 Leverkusen, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a process and an apparatus for the continuous extrusion of a section of any cross-section comprising a foam plastics core with a covering of thermoplastic plastics material. The invention also relates to the section itself. The covering is produced in an extruder having an extrusion die, and the foamable reaction mixture is introduced through a central tube into a hollow space inside the covering formed. The covering is held in a former corresponding to the required shape and is arranged to conform to the shape of the extruder until the foamable mixture has fully reacted.

An apparatus of this kind is already known in which the foamable mixture is introduced into the tubular structure formed by means of a second centrally arranged nozzle simultaneously with the emergence from the extrusion die of the covering consisting of a thermoplast. Sections produced in this way have the disadvantage that the foam core has a lower density along its marginal zone, i.e. near the covering, than in the middle itself. Accordingly, the section formed does not have the required strength, its flexural strength being particularly at fault. The flexural strength of a section can be very considerably increased by means of a reinforced zone, around the margin of the cross-section, whilst strengthening the middle of the section produces hardly any improvement. It is the latter which occurs in the apparatus mentioned above.

It has now surprisingly been found that a section can be made whose foam core as seen in cross-section has a density which decreases from the marginal zone of the core to its centre. In this way, the marginal zone is considerably reinforced because the strength of the foam core are governed very largely by its density and density distribution.

To this end the invention provides a process for the continuous extrusion of a section of plastics covered foam material, wherein a tubular covering skin of thermoplastic plastics material is extruded and maintained in a shape corresponding to the required outer shape of the resulting section, and a foamable liquid reaction mixture is introduced into the cavity thus formed within the covering at a region in which the temperature of the covering has fallen to a temperature not greater than 100°C.

The temperature of the covering at that position where the reaction mixture is introduced should preferably be between 20 and 50°C. In this way, it is possible to avoid heat from the covering causing premature foaming of the liquid foamable reaction mixture.

The distance of the position at which the foamable mixture is introduced from the extrusion die for producing the covering is governed by a number of factors. Firstly, there is the question of the thermoplastic material used to make the covering. For example, polyethylene, polypropylene, polyvinyl chloride, polyvinylidene chlorine, polystyrene, polycarbonate and polyamide may be used for this purpose. The extrusion rate and the outlet temperature from the extruder are further factors, as is the cooling effect produced in the former. The nature of the reaction mixture itself is another influencing factor. Chemical starting components, especially based on polyurethane, as well as unsaturated polyesters, epoxide resins, ε-caprolactam and their copolymers, are suitable for this purpose. The properties of the

expanding agent used have to be taken into consideration as another factor governing the particular choice of the upper temperature limit of the covering at the time the reaction mixture is introduced.

It is relatively easy empirically to determine through tests the most suitable upper temperature limit for each individual case by varying the distance between the extrusion die and the nozzle through which the mixture is introduced, cutting up the section produced and comparing the cross-sectional patterns produced by the various distances.

In one particular embodiment of the process according to the invention, the foaming zone is sealed off from the hotter upstream region to prevent the foamable liquid mixture from flowing back into that region.

The invention also provides an apparatus for the production of a section of plastics covered foam material, comprising an extruder with an extrusion die for forming a tubular covering, a cooled former downstream of the extruder, a delivery pipe for the carrying of foamable liquid mixture projecting from the extruder head of the extruder into a cavity of the former, an outlet nozzle of the delivery pipe being situated in a region in which in use the temperature of the covering has fallen to a temperature not greater than 100°C.

It does not matter whether the cavity in the covering is produced by a pressure active therein, for example by means of compressed air, or by suction air applied from outside. If desired, the delivery pipe may be a forming core so that its external diameter corresponds to the internal diameter of the covering.

In one advantageous embodiment of the apparatus according to the invention, the pipe through which the mixture is delivered is arranged for longitudinal displacement. This has the particular advantage that the point at which the reaction mixture is introduced can be optimally adjusted in accordance with the properties of the materials used, the extrusion rate and the cooling effect.

In another embodiment, a seal in contact with the inner surface of the covering is arranged on the delivery pipe for the mixture upstream of the nozzle. In this way, the reaction mixture is prevented from flowing back behind the nozzle.

As seen in cross-section, a section produced by the process according to the invention has a foam core whose density decreases from its marginal zone to its centre, for example within limits of from 1.2 g/cc. to 0.3 g/cc.

EXAMPLE 1

A tube 50 mm. in diameter with a wall thickness of 1 mm. is extruded from standard polystyrene using a conventional extruder and a so-called cable extrusion die. The extrusion rate is 1 m/minute. The outlet temperature of the tube is 190°C. By virtue of the intensive cooling, the temperature of the tube falls to 75°C at a distance of 500 mm. from the extrusion die. At a distance of 500 mm. upstream of the extrusion die, a polyurethane reaction mixture is continuously introduced through a second nozzle at a rate of 1000 g/minute. The polyurethane reaction mixture has the following composition:

Component A
75 parts by weight of a polyether of ammonia and propylene oxide, OH number 590
20 parts by weight of a polyether of trimethylolpropane and hexane triol reacted with propylene oxide and ethylene oxide, OH number 37
5 parts by weight of 1,4 - butane diol
7.5 parts by weight of trichloromonofluoromethane
1.5 parts by weight of permethylated diethylene triamine
1.0 part by weight of polysiloxane polyalkylene glycolether copolymer.

Component B
122 parts by weight of carbodiimide-modified diphenylmethane - 4,4' - diisocyanate (NCO - content 31%)

The former zone is 4.5 metres long. The cross-section of a plastics section produced in this way has a solid marginal zone of polyurethane plastic of 1.6 mm for a density of 1.2 g/cc.

EXAMPLE 2

A box section or profile measuring 200 mm ×25 mm with a wall thickness of 1.5 mm is extruded from low-pressure polyethylene using a transverse extruder head and a conventional extruder. The outlet rate at the extrusion die is 1 m/minute. The outlet temperature at the extrusion die is 175°C. At a distance of 750 mm upstream of the extrusion die the temperature of the polyethylene profile has fallen to 70°C. At a distance of 750 mm upstream of the extrusion die, a reaction mixture is continuously introduced through a second nozzle in a quantity of 2.5 kg/min.

The reaction mixture has the following composition:

Component A
150 parts by weight of an unsaturated polyester resin
3 parts by weight of the Na-salt of sulphonated ricinoleic acid in 50% aqueous solution
2.5 parts by weight of bis - (dimethylethylamino) - methylamine
1 part by weight of dimethyl polysiloxane

Component B
4.5 parts by weight of methylethylketone

Component C

30 parts by weight of a crude, 4 - 4′ - diphenylmethane diisocyanate

The former zone is 5.5 metres long. After the polyethylene covering has been drawn off, the cross-section of the section produced in this way has a solid marginal zone of 1.7 mm for a density of 1.1 g/cc. which in the core falls to 0.37 g/cc.

EXAMPLE 3

Instead of the polystyrene covering of Example 1 and the polyethylene covering of Example 2, a covering is produced from acrylonitrile - butadiene - styrene polymer with a wall thickness of 1 mm. The die outlet temperature is 180°C. As in Example 1, the temperature of the tube 500 mm upstream of the extrusion die is 75°C. Further processing is carried out as in Example 1 and 2.

EXAMPLE 4

A covering is extruded from polyamide. The die outlet temperature is 230°C. The cooling zone is 900 mm. long. The wall thickness of the covering is 1.5 mm. The temperature in the nozzle for introducing the reaction mixture is 85°C. Further processing is carried out as in Example 1.

Embodiments of the process according to the invention, the apparatus according to the invention and the section according to the invention are described by way of example in the following with reference to the accompanying drawings, wherein:

Figure 1 is a purely diagrammatic side elevation of the apparatus in section,

Figure 2 is a cross-section through the profile or section produced by means of the invention,

Figure 3 shows the density distribution in the section shown in Figure 2.

In Figure 1, a thermoplastics material is fused in an extruder 1 (diagrammatically illustrated) and extruded through an extrusion die 2. The covering 3 thus formed is then introduced into a former 4 which is provided with a cooling jacket 5 and in addition comprises a suction chamber 6 which applies suction to the covering 3 so that the covering 3 defines a cavity 8 in the former 4. The reactable mixture is stored in a cooling chamber 9 from which a delivery pipe 10 for the mixture projects into the former. The nozzle 11 of the delivery pipe opens in that region of the former in which the temperature of the covering 3 has already fallen at least to 100°C. and preferably to such temperature as may be regarded as optimal in the circumstances. To enable the apparatus to be adapted to use different materials, the delivery pipe 10 for the mixture is arranged for longitudinal displacement so that the nozzle 11 is adjustable in regard to its distance from the extrusion die. A sealing ring 12 is used both to seal the cavity 8 and at the same time to guide the longitudinally displaceable delivery pipe 10. Just upstream of the nozzle 11, the delivery pipe 10 is surrounded by a sealing ring 13 whose peripheral surface is in contact with the inner surface of the covering 3 and prevents the reaction mixture 14 introduced into the covering from flowing back into the hotter region of the covering. The reaction mixture 14 then expands to form a foam core 15.

In Figure 2, the cross-section of the completed profile shows the covering 3 of a thermoplastic plastics material and the foam core 15 which in its marginal zone 16, i.e. immediately beneath the covering 3, has a much higher density than at its centre 17. In the marginal zone 16 (Figure 3) the density may for example, be 1.2 g/cc. whilst at the centre of the core 17 it can be 0.4 g/cc. for example.

WHAT WE CLAIM IS:—

1. A process for the continuous extrusion of a section of plastics covered foam material, wherein a tubular covering skin of thermoplastic plastics material is extruded and maintained in a shape corresponding to the required outer shape of the resulting section, and a foamable liquid reaction mixture is introduced into the cavity thus formed within the covering at a region in which the temperature of the covering has fallen to a temperature not greater than 100°C.

2. A process as claimed in Claim 1, wherein the temperature of the covering where the reaction mixture is introduced is between 20°C and 50°C.

3. A process as claimed in Claim 1 or 2, wherein foaming takes place in a zone which is sealed off from the hotter upstream region.

4. A process for the continuous extrusion of a section of plastics covered foam material spbstantially as herein described with reference to the accompanying drawings.

5. An apparatus for the production of a section of plastics covered foam material, comprising an extruder with an extrusion die for forming a tubular covering, a cooled former downstream of the extruder, a delivery pipe for the carrying of foamable liquid mixture projecting from the extruder head of the extruder into a cavity of the former, an outlet nozzle of the delivery pipe being situated in a region in which in use the temperature of the covering has fallen to a temperature not greater than 100°C.

6. An apparatus as claimed in Claim 5, wherein the delivery pipe is longitudinally adjustable.

7. An apparatus as claiamed in Claim 5 or 6, wherein a seal adapted to contact the inner surface of the covering is arranged on the delivery pipe upstream of the nozzle.

8. An apparatus for the continuous ex-

trusion of a length of plastics-covered foam, substantially as herein described with reference to the accompanying drawings.

9. Plastics-covered foam material when produced by a process as claimed in any one of Claims 1 to 4.

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1273706 COMPLETE SPECIFICATION

1 SHEET This drawing is a reproduction of the Original on a reduced scale

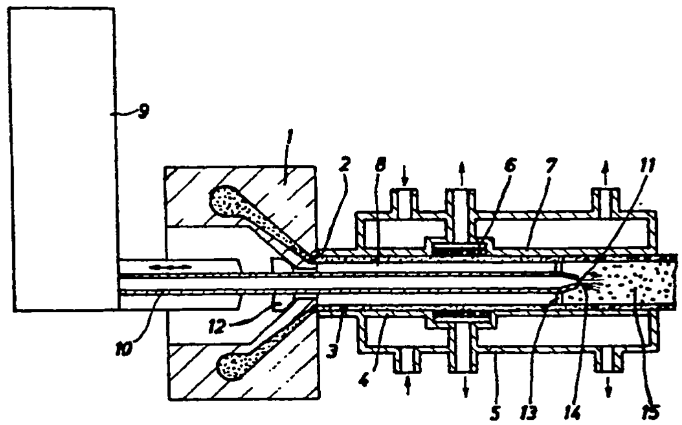

FIG.1

FIG.2

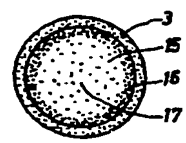

FIG.3